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adjacent parenchyma, though at first richer in chromatin. In most active nectaries they are said to have a predilection for blue stain, though in some cases they have been found, either at first or throughout, to take the red stain by preference.

The behavior of the chromatin and nucleolar contents of the nuclei during activity of the gland appears to differ greatly in different plants, but in general one or both diminishes noticeably. Nuclei becomes deformed and lobed or even fragmented, send out pseudopodia like prolongations to the ends of which plasma threads become attached, or the nuclear membrane is absorbed and the nuclear material diffuses in the cytoplasm, which itself gradually diminishes or even disappears; meantime the starch accumulation in the vicinity of the nectary is used up, though some reserve starch is often brought into this tissue later.

In the main the descriptions of structure are clearly written, and the plates are all excellently drawn and reproduced. If any fault were to be found with the paper it would be that the student of a given genus or species is confused by the division of the work and plates into separate sections, each of which contains partial studies of a number of species, which, in the absence of a general index, cannot well be united by the reader.—W. T.

Physiological plant anatomy.[5]

THE first edition of this book appeared in 1884. In its preface the author explains that his endeavor was to make plain the connection between anatomical structure and physiological performance. In the preface of the present edition the author states that the subject has made such progress that the book must be much enlarged. The plan and manner of arrangement has not been materially changed, about 150 pages and 95 illustrations having been added. The same number of chapters is retained, although an entirely new one on the apparatus for special functions is added; the two on normal and abnormal growth in thickness being here combined. An introduction and a discussion of the plant cell is added to the first chapter. In short, while still holding to the same object as before, the book is enlarged and improved in every chapter. The author says of the new edition:

> It is no longer the elements of physiological anatomy, but a veritable text-book; not a hand book or cyclopedia, because a great deal of relevant matter has been omitted. All the research that serves only to broaden our knowledge is omitted, and only that used which has deepened it.

One of the most helpful additions to the new edition is the introduction, where the author states clearly and fully the meaning of the expression "physiological plant anatomy." In doing this he gives a new significance to

[5] HABERLANDT, DR. G.—Physiologische Pflanzenanatomie, Wilhelm Engelmann: Leipzig. 1896.

the word anatomy, a meaning which is necessary to the very conception of physiological anatomy. He defines the scope of morphology as including the outer and inner structure. The inner structure includes histology and anatomy; as far as the inner structure is confined to the elements of the separate tissues, it is histology; when we go farther and consider the tissues in relation to their position and arrangement in the plant, it is anatomy. This brings out clearly the principle upon which physiological anatomy is based, that is, the connection between function and form, when form is limited to certain tissues and combinations of tissues inside the plant. These tissues and combinations of tissues are therefore to be considered as organs in the real sense of the term, and not simply as the component parts of the plant.

Another prominent feature of this book is the copious notes or references at the end of each chapter. Here are discussed in detail those points of the text which may be considered debatable, and all the authorities on such questions are cited. For example, Strasburger maintains that the anatomical-physiological idea is not a part of morphology, but must be considered as belonging to physiology. He expressly states that morphology is based upon phylogenetic principles only and has nothing whatever to do with the idea of function. This Haberlandt considers a too narrow conception of morphology. He makes phylogenetic morphology only a branch of the whole subject, saying that as we characterize a tissue or tissue system, like the palisade tissue or the skeleton system, by its morphological qualities as well as by its physiological performance, we must admit that such tissues and systems may be treated from a morphological standpoint.

He further claims that this method of classification of tissues is the broadest of all and the only one based on purely scientific principles, because it considers the plant as an individual organism consisting of elementary organs by virtue of which it is enabled to carry on a series of life processes.

Other methods of classification may be used, but they must be carried out in a manner consistent with the principles upon which they are founded. But a method purely didactic, which aims only to form a convenient basis for a general view of the different tissues cannot be called scientific. These clearly expressed statements of the two opposing views concerning the nature and scope of morphology are of special interest at the present time, as they serve to define the principles held by physiological anatomists, as contrasted with modern morphologists. For example, Strasburger maintains that phylogeny is the only basis of morphology, and that the only way to determine morphological characteristics is to show that one form has been derived from another. But Haberlandt claims that we do find certain morphological characteristics in any cell complex which is sufficiently unified to be called an organ, or to have a separate individual function. Therefore, we are justified in disregarding the notion of phylogeny, and in constructing a set of tissue systems from purely ontogenetic considerations, and of these we may choose only those pertaining to function. On the other hand, we are also justified in classifying the tissue systems according to phylogenetic principles, but this is not the most logical method.

These statements are also of importance in showing the advance actually made in this subject during the past twelve years. Twelve years ago botanists were unwilling to relinquish the idea of the unity of the so-called fibrovascular bundle, and still regarded the views of Schwendener on the primary function of the thick walled cells of the monocotyledons with a certain degree of suspicion. All this is changed, and in all our recent text-books in which this subject is treated, the complete bundle is spoken of as consisting of stereom and mestom, and the elements of the former are described as mechanical or supporting cells. Thus the truth of the first principle upon which physiological anatomy was founded is fully recognized and admitted by all.

The first chapter of Haberlandt's book contains a full and modern treatment of the typical plant cell, a description of plant tissue, and a classification of tissue systems according to the anatomical physiological principle.

The second chapter treats of tissues in general and the relation of meristems to lasting tissues, and here we find a departure from the interpretation usually given to the developmental processes of the apical region. In all higher plants, at a greater or less distance from the apex, the uniform primary meristem cells differentiate into several distinct building tissues or meristems. These at first show no difference of outer or inner meristems, except the mere topographical one and the histological difference between strand-tissue and ground parenchyma. Regarding the function of the lasting tissue which is to be developed they give no hint. These primary meristems are not necessarily connected with any special kind of apical growth as regards their origin or arrangement. They may be found in plants having only a single apical cell, also in those with several initial cells. That is, three distinct meristems, which Haberlandt names protoderm, procambium, and ground tissue, may be found in the apical regions of plants from the moss upward. He states that since the time of Hanstein's investigations many plants have been examined which do not show a separation into the three distinct meristems, plerome, periblem and dermatogen, and that the manner of apical growth in the phanerogams is subject to too great variation to allow the selection of a single type as furnishing a general law.

The succeeding chapters treat of the eight tissue systems. The plan in each case is to explain first the advantages which the plant derives from the system under consideration, and then to give a clear and full description of its elements and their relations to other parts of the plant. A short paragraph in each chapter is devoted to the system as it occurs in the thallophytes, and its developmental history forms the concluding paragraphs of each chapter, except in the case of the absorption system where such an exposition is unnecessary. The chapters on the absorption and assimilation systems are considerably enlarged, the former by a paragraph on the absorption of water by the hairs of foliage leaves. The chapter on the conducting system is also much enlarged, the author giving an exposition of the theories of water conduction and explaining the present status of our knowledge of this difficult and perplexing subject. Another section of the same chapter illustrates the author's idea of the dependence of form upon function, that is, that organs are called into existence by some special need of the plant. In this connection he gives an hypothesis concerning the probable manner of development of the different kinds of bundles.

The chapter on apparatus for special purposes contains a description of the various means of plant motion. The passive organs are the flying and swimming tissues which are fully described and illustrated. The active tissues are described as hygroscopic and living, the latter including those through which movements are caused by outer stimuli. The tissues supposed to receive stimuli and those designed only for their conduction are fully treated.

In style the book is exceedingly clear and attractive, and the principles upon which its method of treatment rests are now admitted by all. It is questioned by some, however, whether this classification of tissue systems should be substituted for the older and simpler one which is now in general use. The objections are that it presupposes at least a partial knowledge of the tissues, and that it is too extended to find a place in a text-book on general botany. Both of these objections have more weight perhaps in this country than in Germany. It is also true that the simpler method is far more practical for students of pharmacy and medicine, and for any others who wish only a general view of this branch of botany. In view of these considerations it would seem wiser for us, at least, to precede such a view as Haberlandt presents by a general view based simply upon didactic principles.—EMILY L. GREGORY.

NOTES FOR STUDENTS.

THE ACTION of the yeast cell during alcoholic fermentation has always been a difficult matter for the physiologist to explain. Most writers for the last twenty-five years have considered fermentation a specific form of protoplasmic activity, possessed by certain species of lower plants in a highly developed form. The view of Traube (1858) and of Hoppe-Seyler, ascribing fermentative action to an albuminoid compound secreted by the yeast cell, allied in its nature to the enzymes, has never found favor with botanists. Nägeli in his carefully considered theory of fermentation (1879) pointed out very important differences between the behavior of so-called organized and unorganized ferments, and laid particular stress upon the fact that it had